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Optimized Passive Network for 4G Communication

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Abstract— **Day to day rapid growth of communication requires high speed data transmission with best Quality of service (QoS) .For upgrading generation in telecommunication we need to focus on differences in technologies in generation like 3G and 4G. In this project we mainly focus on differences between technologies in 3G and 4G . Applying an optimized solution for high data transfer rates and high QoS. Comparing technologies using 3G and 4G we can observe the major parameter in Bandwidth. To improve bandwidth availability we will choose optical fiber as communication channels. A passive optical network (PON) is a reliable back haul technology, which can provide high bandwidth and is highly cost effective. The combination of 4G with NG-PON creates an access network that is cost efficient, reliable, flexible as well as facilitating mobility and ubiquity. However, this integration has many challenges such as maintaining the QoS of whole network. In this paper, we propose the NG PON as an alternative solution for the point to point fiber in the 4G centralized co-ordinated Multi-Point (COMP) transmission and reception. This architecture is for joint transmission downlink COMP which benefits from the broadcasting transmission in the downlink of PON.**

Keywords- Link-capacity; Physical layer Impairments; Q-factor; Light-path; Power loss; Data-path.

I. INTRODUCTION

Day to day growth in telecommunication network requires functionalities like dynamic data-path selection with guaranteed Quality of service (QoS) [1] [2], which are essential for any optical network. Data-path selection of the WDM network depends on the physical as well as IP layer information. The degradation of data-path may happen due to Physical layer impairments (PLI). WDM (Wavelength Division Multiplexing) technology is growing day-by-day in accordance with the requirement of clients. The basic requirement of clients is QoS (Quality of Service), which depends on various parameters in network as well as in physical layer. In order to satisfy such Requirements, it is necessary to search for a data-path in WDM network. The optical information on data-paths are generally affected or degraded by various constraints such as physical layer impairments [3]. Q-Factor can be widely used as a system performance indicator for optical communication systems since it is directly related to system-bit error rate. This also can be used for light-path routing. There are few PLI based routing algorithms considered in[7]. The advantages of Q-Factor [9] include rate transparency and in service performance monitoring in addition to fast and compete performance analysis.

In this paper, we focus on PLI Impairments, which are defined as the parameter effect in the physical layer while establishing the connection between source nodes to destination node. The main objectives of this paper is to when and how to select a data-path.

II. PROBLEM FORMULATION

We consider a network node topology by considering a number of flows for a source-destination pair. The traffic requirement for all the flows can be aggregated at the source node, in-order to select a best possible data-path. In following section, we proposed a capacity and PLI model based on the existing traffic load on the network. Finally best possible data-path will be decided depending on the client requirements and existing traffic.

A. Capacity Model

Assume there are client *m* and *n* for a source (*s*) and destination (*d*) pair with multiple data-paths. Those data-paths can be computed using any generic path finding algorithm. We consider a capacity matrix, $C(m,n,s,d)$ for all the possible data-paths. If *D (i, j)* is the dispersion of the fiber at the operating wavelength, *SW (i, j)* is the spectral width of the light source in, and *L (i, j)* is the length of fiber link pair *(i, j)*, then the capacity matrix for single data-path can be explained [7] as follows:

$$C(m,n,s,d) = \sum_{(i,j)\in p(m,n,s,d)} \frac{0.187}{D(i,j)\times SW(i,j)\times L(i,j)} \quad (1)$$

Where, *D (i, j)* = *SW (i, j)* = *L (i, j)* = 0, when there is no link between i^{th} and j^{th} node.

The capacity matrix is derived from a single link to a group of links in a data-path.

B. PLI model

In optical network, normally a data-path is affected by several physical layer impairments. Those PLI constraints impacts on the overall network performance. In order to provide a qualitatively a good data-path, it needs to analyze the networks. We consider data-path quality in-terms of Q-Factor. Sometimes the Q-Factor also termed as link cost or path cost. The Q-factor (QF_i) for i^{th} link is given [8] as below:

$$QF_i = \frac{\sum_{k=1}^{N_i} 10\log\left[Q_{i,k}^{s} / Q_{i,k}^{d}\right]}{N_k} \quad (2)$$

Where, N_k is the number of light-path at the i^{th} link, $Q_{i,k}^{s}$ and $Q_{i,k}^{d}$ are the link cost of the k^{th} light-path at the source (s) and destination (d) node of the i^{th} link respectively. If $p(m,n,s,d)$ is the light-path containing l number of links, the overall factor $QF_{overall}(p(m,n,s,d))$ will be:

$$QF_{overall}(p(m,n,s,d)) = \sum_{i}^{l} QF_i \tag{3}$$

Further according to [9],

$$\frac{Q_{i,k}^{s}}{Q_{i,k}^{d}} = \frac{1}{(\delta_{eye}(i,k)) \times (\delta_{noise}(i,k))} \tag{4}$$

Where $(\delta_{eye}(i,k)), (\delta_{noise}(i,k))$ are Eye penalty and Noise penalty at i^{th} link and k^{th} light-path.
Then equation 1.4 becomes,

$$QF_i = \frac{\sum_{k=1}^{N_i} 10 \log\left[1/(\delta_{eye}(i,k)) \times (\delta_{noise}(i,k))\right]}{N_k} \tag{5}$$

Due to amplifier spans, the channel lunch power can be relatively low without significant penalties due to noise accumulation. The eye related penalty is due to the effect of linear physical impairments such as polarization mode dispersion (PMD) and chromatic dispersion (CD), while the noise related penalty is due to the effect of amplifier spontaneous emission (ASE) and crosstalk.

$$\delta_{noise}(i,k) = \frac{P^d}{p^s} \times \frac{1}{\sqrt{F}} \tag{6}$$

Where, P^d is the outputs signal power, P^s is the input signal power and F is the noise figure and $P^d = P^s e^{-\alpha L}$, α is the attenuation constant and L is the length of the data-path.

$$\delta_{eye}(i,k) = \delta_{pmd}(i,k) \times \delta_{cd}(i,k) = 10.2 \times C(i,k)^2 \times D(i,k)_P^2 \times L(i,k) \times \delta(i,k)_{cd} \tag{7}$$

Where, $C(i,k)$ is the capacity, $D(i,k)_P$ is the PMD parameter and $L(i,k)$ is the transmission length.

III. DATA PATH SELECTION MECHANISM

We have considered three different scenarios for data-path selection mechanism, such as Selection of new data-path based on a) Power loss, b) Channel capacity, and c) Q- factor of the path[10].

Data-path selection based on power loss: For this case we analyze the power loss for all possible paths existing in between source and destination. The data-path, which is having the minimal power loss, will be selected as the best path.

Data-path selection based on Channel capacity: The capacity matrix will be analyzed (1) for all possible data-paths, among all which has the highest channel capacity that can be chosen as the best path.

Data-path selection based on Q-factor: This method is the combination of both the above scenarios. For this case we analyze Q-Factor (3) for all possible data-paths, among all which has highest Q-factor that will be chosen as the best path.

IV. SIMULATION RESULTS AND DISCUSSION

The Figure 1 shows the basic network topology with four nodes mesh network. Here we considered one pair of source and destination nodes (1, 3).

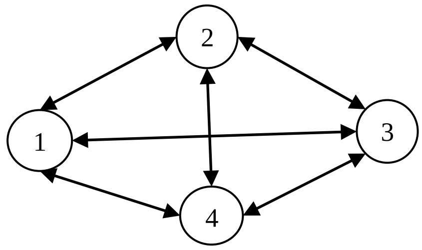

Figure 1. Network Topology Graph

Based on our data-path selection mechanism, a best possible data-path will be chosen for a source and destinations pair. We have simulated the above topology by considering the following parameters mentioned in table1.

TABLE I. PARAMETERS USED IN SIMULATION

Parameter	**Values**
Attenuation Constant(α)	0.15db
Chromatic dispersion (δ_{cd})	3000 ps
Wavelength of light (λ)	1532 nm
Noise Figure(F)	0.4db

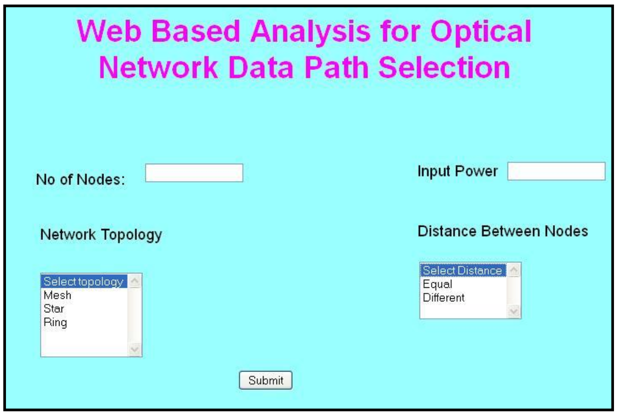

Figure 2. First page for user

By using problem formulation we are going to calculate the physical layer impairments like power loss, channel capacity and quality factor. This calculation happens in back end. We are applying .net environment for front end page. In that front end we will give the web link to the user as shown in the following figures.

The fig. 2 the first page for client for taking the no of nodes, input power, network topology style and distance between nodes values. By submitting data in front page we will go for next page shown in below figure.

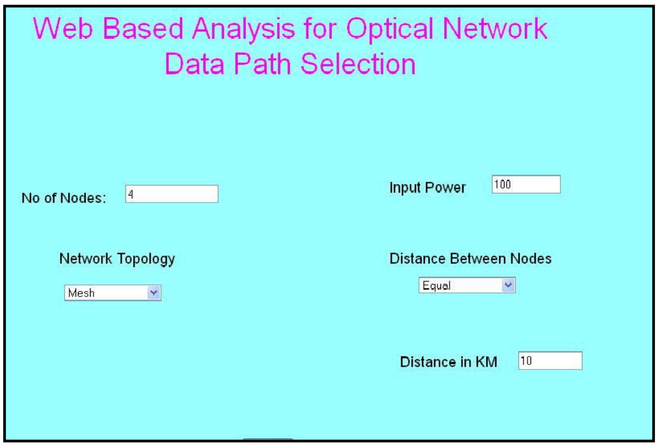

Figure 3. Page 2 for client

The above page shows the input data of the network. After applying the data, it will process through matlab program in back end and result will be given back to the web page (front end).the following result page shows the information about network to the user.

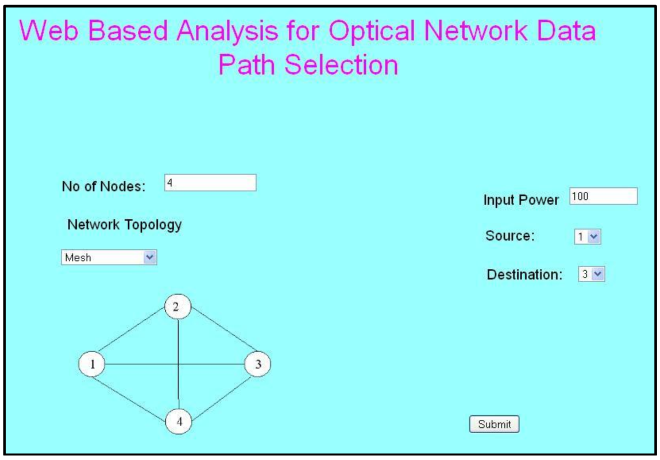

Figure 4. Page about network information

The above work shows the front end to the user the further results describe about back end to the user. Internally we are going to calculate power loss, channel capacity and quality factor for all possible paths in between source node 1 and destination 3 nodes.

TABLE II. POWER LOSS CALCULATION

SN	DN	Path	PL(db)	Ref. No	BP
1	3	1-2-3	97.02	1	2
		1-4-3	77.68	2	
		1-3	97.02	3	

The above table 2 shows the various power loss values for different possible paths in between 1 and 3.

By observing the data mentioned above the second path has lowest power loss. So that second path selected as best path.

TABLE III. CAPACITY CALCULATION

SN	DN	Path	Capacity of path	Ref. No	BP
1	3	1-2-3	0.0169	1	2
		1-4-3	0.0405	2	
		1-3	0.0169	3	

The above table 3 shows the various path capacity values for different possible paths in between 1 and 3.

By observing the data mentioned above, we can choose second path as best path.

TABLE IV. Q-FACTOR CALCULATION

SN	DN	Path	Q-Factor of path	Ref. No	BP
1	3	1-2-3	18.81	1	2
		1-4-3	25.33	2	
		1-3	18.81	3	

The above table 4 shows the various path Q-Factor values for different possible paths in between 1 and 3.

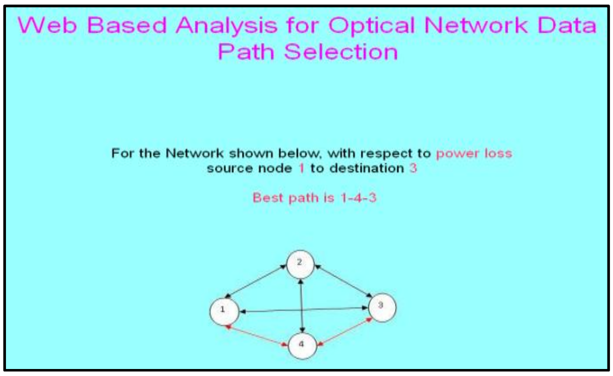

Figure 5. Result page with respect to power loss

The above figure describes about path selection with respect to power loss. By the figure the user can understand which one is best path.

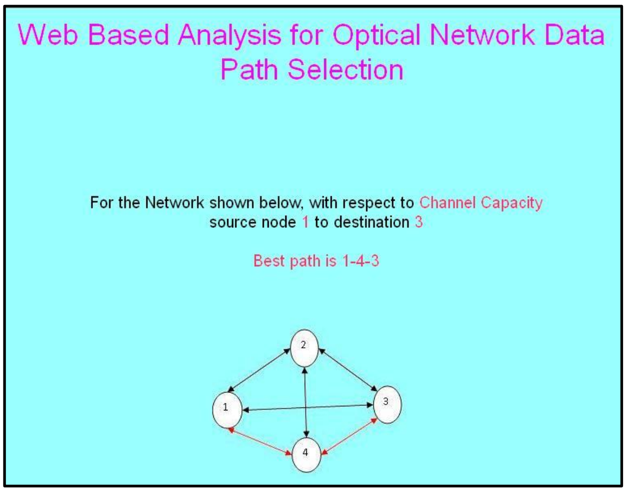

Figure 6. Result page with respect to Channel capacity

The above figure describes about path selection with respect to channel capacity. By the figure the user can understand which one is best path.

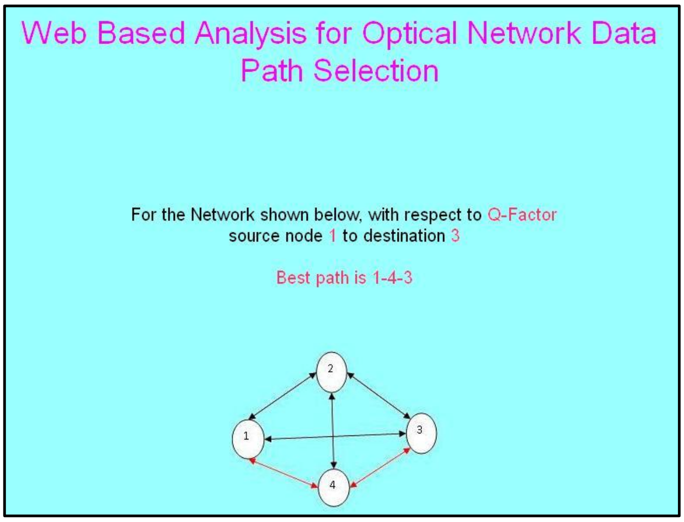

Figure 7. Result page with respect to Q-Factor

By observing the data mentioned above second path has highest Q-Factor. So that path will choose as best path.

By getting all the backend result we can display final result based on client requirement.

Final output pages shows the details about best path based on power loss, channel capacity and Q-Factor

The above figure describes about path selection with respect to Q-Factor. By the figure the user can understand which one is best path.

V . CONCLUSION

In our simulation, we have considered power loss, path capacity and finally Q-Factor for a given source-destination pair. Our proposed algorithm helps to analyze those constraints and determines the best possible data-path in between source-destination pair. The result shows the variations of power losses, channel capacity and quality factor for all possible data-paths for the clients. These results will given two to the users effectively with .net interfacing. Finally the best data-path has been selected based on the requirements of the client.

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